Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2018-184-AC2, 2018
© Author(s) 2018. This work is distributed under
the Creative Commons Attribution 4.0 License.

Hydrology and Earth System Sciences Discussions

Interactive comment on "Explorative Analysis of Long Time Series of Very High Resolution Spatial Rainfall" *by* E. Dybro Thomassen et al.

E. Dybro Thomassen et al.

edth@env.dtu.dk

Received and published: 13 July 2018

Thank you for the thorough review of our manuscript, it is very much appreciated. In the following we will do our best to reply to your comments and suggestions. [page lines]

[2 18] Thank you for providing relevant references. Neither Scopus nor WoS has made the paper by Benoit et al (2018) available yet, but we will include references to Peleg et al (2017) and Peleg and Morin (2014) in the context of highlighting that recent research explores this field. We will likewise identify other suitable domains where the study is relevant, cf. the response to reviewer 2.

[2 24] In line with the comment above, we are happy to include the two suggested

references in the revised manuscript.

[Case area] We will add a short introduction to the climatology in the case area. Regarding the – high urbanisation – it is not shown in Figure 1, but just stated. We believe it is well known that urban areas are vulnerable to highly convective events, which leads to the damage potential. As the paper does not otherwise focus on this we will not go into further details, but we can add some citation stating the observed damages.

[3 22] We will add more information on the radar data product used. The probability for a difference of more than 5 mm between radar data and independent stations (stations not used for radar data adjustment) is 1.4 per station per year. The probability of a difference above 10 mm is 0.1 per station per year (for the methodology, see Einfalt & Frerk, 2011). An analysis of the first 10 years of data shows that there is an underestimation of extreme events for short time steps, which is reduced with growing time intervals (Scheibel & Einfalt, 2015).

[Spatial selection of extreme events] We will elaborate more on this part. SS1 is chosen as the grid cell is in the middle of the catchment and SS1 represent how you would select extreme events from a rain gauge. The chosen grid cell will have great impact on which extreme events you sample; this will be more clear when section 3.3.3 and 4.2.3 and table 3 is explained better. SS2: The five grid cells are chosen to represent a spatial coverage of an urban area, but could also have been connected grid cells. By selecting grid cells with a spatial distance similar to the distances between rain gauges in a city, it is possible to analyse how different events sampled is within a small range, see section 3.3.3.

[5 3] Actually the events are sampled independent of each other with SS1, again to mimic point rainfall measurements. The short distance spatial differences in variation of seasonal occurrence of extreme events are analysed by comparing the result for the five grid cells, which are included in SS2. This will be clarified in the revised version of the paper.

[5 7] Yes, because of the computational time, but also because the correlation between neighbouring cells is clearly very high and calculating that for the entire dataset does not add value matching the extra computational effort.

[5 19] and [5 22] Yes, thank you.

[Spatial variation] We see this comment as a follow up on comment [5 3] and will change the text to make it more clear that the spatial variation in extreme events using SS1 is calculated for the five grid cells from SS2 to analyse the difference in sampled extreme events when changing the grid cell in SS1. The black filled grid cell is used as a reference and compared to the four grey filled grid cells (Figure 2). Extreme events are sampled independent from each of the five grid cells. The number of concurrent events are calculated using Equation 1.

[6 7-9] We agree with the reviewer that the cell tracking procedure could be more advanced. However, we have checked manually that it works well in identifying cells and cell movement and the thresholds applied align well with well-known cell identification and tracking algorithms (Kyznarova and Novak, 2009; Handwerker, 2002; Peleg and Morin, 2012; Dixon and Wiener, 1993). The purpose of introducing thresholds in this paper is to reduce the noise in the tracking, by only tracking rain cells of a certain size and intensity and to compare the importance of this variable to the many other variables use to describe precipitation in the study. Changing thresholds, including performing a sensitivity analysis, would not change the findings of the paper and hence we would prefer not to report the analysis, since it may imply a shift of focus of the paper.

[6 9] Will be corrected to: "The intensity threshold is chosen to be event varying to distinguish. . ."

[Subsection 3.5.1-3.5.3] We will revise the section and shorten it further, e.g. by referring to the R-packages that we have applied.

[9 8-10] We will revise the sentence to state that the results from Table 2 indicate

that meteorologically independent events are joined when grid cells in a large part of the catchment are considered, which argues that SS3 and SS4 cannot be used. The seasonal distribution of events between SS1 and SS2 does not change and both methods can be considered as sampling strategies for spatial rain events. In order to use the knowledge about extreme events from rain gauge data and compare results SS1 is chosen as the sampling strategy.

[9 18] The two terms will be explained briefly to help the reader understand the clustering later in the article.

[Spatial correlation] Thank you, we will include some of the references above in the discussion of our results.

[Table 3] We hope that the results are easier to understand after we have revised section 3.3.3 as outlined above [Spatial variation]

[Principal component analysis] We agree that the cluster analysis contribute with more interesting results. However, the PCA provides a first result on the amount of information in the data and the cluster analysis builds upon the principal component analysis. Hence we find it important to analyse and report the results of the principal analysis before applying the cluster analysis. We agree with the reviewer that the principal component analysis alone cannot specify the most important variables for characterising events, but it helps specify the number of variables necessary and suggests which variables clusters convective events from frontal events.

[Cluster analysis] We did consider to focus on three clusters, that could be interpreted as: very extreme convective events, convective events and frontal events, i.e. not very different from what discovered with the principal component analysis. What is interesting with four clusters is that the clustering can still be described by well-known weather phenomena. We will include this in our discussion of the results. We haven't included temperature or atmospheric pressure in the analysis, but agree with the reviewer that these variables might be of interest, especially if making simulations of a weather generator by conditioning on the current state of the atmosphere.

[12 18] The events are sampled using one grid cell (SS1) and as shown in 4.2.3 a small change in location of the given grid cells changes the sampled extreme events a lot. But still we find this method the most appropriate to sample independent extreme events. However the analysis of the extreme events sampled are performed on the entire radar image. The characterisation of the extreme events by the 16 variables and the rain cell identification and tracking is not affected by the sampling strategy. The sampling strategy only determines which events are analysed.

[12 21-22] Thank you for pointing us towards these very recent studies, we will relate our results to them. We still think the main conclusion is that the scientific field has not reached consensus on how to characterize precipitation extremes except when based on point measurements.

[Title] We will consider changing the title to reflect the content of the article best possible. When changing the title we will keep in mind that one of the characteristics that make this data set rather unique is that it has been validated and corrected against ground measurement, while many other studies focus on analysis of the outputs from the weather radars without correcting for the shortcomings of this measurement device.

[Figure 1] The location of the radars and the distance to the case area will we added to section 2.2. We agree that the three sub-figures in Figure 1 and 2 to some extend contain redundant information, but found it difficult to read the plot if the two subfigures were merged. We will give it another try.

[Figure 6 and 9] We will consider moving the suggested Figures to the supplementary material if it does not add value to the reader after all the other suggested revisions have been made.

References: Dixon M, Wiener G. 1993. TITAN - Thunderstorm Identification, Tracking, Analysis, And Nowcasting - A Radar-Based Methodology. Journal Of Atmospheric And

Oceanic Technology, 10, 6, 785-797

Einfalt, T., Frerk, I. (2011) On the influence of high quality rain gauge data for radar-based rainfall estimation, Proceedings 12th ICUD, Porto Alegre, 11-15 September.

Einfalt, T., Scheibel, M. (2015) Vergleich von Extremwertstatistiken aus Radarmessungen und Regenschreibern. Hydrologie und Wasserbewirtschaftung, 35.15.

Handwerker J. 2002. Cell tracking with TRACE3D - a new algorithm, Atmospheric Research, 61, 1, 15-34.

Kyznarova and Novak P. 2009. CELLTRACK - Convective cell tracking algorithm and its use for deriving life cycle characteristics. Atmospheric Research, 93, 1-3, 317-327

Peleg N, Morin E. 2012. Convective rain cells: Radar-derived spatiotemporal characteristics and synoptic patterns over the eastern Mediterranean. Journal of Geophysical Research - Atmospheres, 117, D15116

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2018-184, 2018.